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THE USE OF GRIDDED BINARY CODE IN PRODUCING PRODUCTS FROM BRACKNELL FOR INTERNATIONAL EXCHANGE IN FM92-IX GRIB (Edition 1)

BY

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Headquarters, Bracknell

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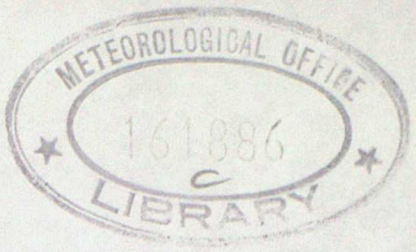

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ON THE USE OF GRIDDED BINARY CODE IN PRODUCING PRODUCTS FROM BRACKNELL FOR INTERNATIONAL EXCHANGE IN FM92-IX GRIB (Edition 1)

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GRIDDED BINARY NWP PRODUCTS FROM BRACKNELL IN FM92 - IX GRIB

Introduction

GRIB (GRIdded Binary) code is a general purpose bit-orientated code developed by WMO as a highly efficient data exchange format, used for transmitting large volumes of gridded data over high speed telecommunication lines. The data is packed into GRIB code making the bulletins more compact, o decreasing the transmission time between computers. Each bulletin contains a grid point field of a single parameter at a single level, as a continuous bit-stream made of a sequence of octets (1 octet = 8 bits) within a communications envelope. The octets of a GRIB message are grouped in blocks. Each block will always contain an even number of octets, which may mean zero filling at the end of a block. The Bracknell GRIB code bulletins consist of five or six blocks preceded by a WMO abbreviated heading as follows:

WMO header
Indicator block (IB)
Product definition block (PDB)
Grid description block (GDB)
Bitmap block (BMB) (optional)
Binary data block (BDB)
End block (EB)

The WMO header is part of the telecommunications envelope, which for the present is character-orientated, content dependent and contains the standard WMO abbreviated heading. This header should not be used as the sole determiner of the message content; the Product Definition Block should be the main determiner.

In the message, as transmitted on the communications lines, the WMO header is preceded by sixteen octets of 'communications header'. The communications people also add an ASCII 'carriage return, carriage return, line feed, end of transmission string', - (0D0D0A03) hex - after the End Block.

In this documentation, all hexadecimal numbers are enclosed in parentheses followed by the word 'hex', decimal numbers are printed as they are and a single string of characters is represented inside single quotes. Character representation in GRIB is in standard 7-bit ASCII (or International Alphabet No.5).

Data Packing Method

Data are coded as binary integers using the minimum number of bits required for accuracy; values are given relative to an encoded reference value and are scaled by a power of two. The representation of a single value is such that:

$Y = R + (X * 2^{**}E)$ where

Y = real value
R = reference value (32 bits)
X = packed value
E = scale factor (sign bit, followed by a 15 bit integer)

The reference value R is, for our purposes, always the minimum value of the data that is being represented in the code. R is a four octet single precision floating point number, with the first bit representing the sign bit, the next seven the characteristic, and the remaining 24 bits the mantissa.

The Communications Header

This precedes the WMO bulletin header.

Octet No.	
1	SOH start of header control character (01) hex.
2-4	Two ASCII carriage returns and a line feed (0D0D0A) hex.
5-7	3 character sequence number assigned to a particular transmission block by the communications software at time of transmission.
8-10	Two ASCII carriage returns and a line feed (0D0D0A) hex.

WMO Bulletin Header

The WMO abbreviated heading is used to identify the GRIB message at present, although as mentioned earlier it should not be the sole determiner of the message contents.

The characteristics in the WMO bulletin header are in ASCII (or CCITT-ITA N0.5) and are defined as follows:

Octet No.	
1	The character 'H' identifies the bulletin as being in GRIB code.
2	A letter character specifies the type of parameter, see Table 1.
3	A letter character specifies the gird area, see Table 2.
4	A letter character indicating the time difference between the reference time and valid time of the data, see Table 3.
5-6	Two numeric characters specifying the level of the data, see Table 4.
7	blank (20) hex.
8-11	Four characters identifying the originating centre. These are always 'EGRR' for Bracknell products.
12	blank (20) hex.
13-14	Two numeric characters providing the reference day of the month.
15-18	Four numeric characters providing the reference hour and minute of the data in the product message.
19-21	Two ASCII carriage returns and a line feed (0D0D0A) hex.

Indicator block (IB)

Octet No.	
1	'GRIB' (coded CCITT-ITA N0.5).
5-7	Total length of GRIB message.
8	GRIB edition number (1 for this implementation).

Product Definition Block (PDB)

Octet No.

1-3	Length of block (in our case 28 octets).
4	Version number of parameter table (1 for this implementation).
5	Identification of centre; Bracknell is 4A (hex).
6	Model identification, see Table 5.
7	Grid identification, see Table 2.
8	Indicator for presence of Grid Description Block and Bit Map block (see Note 1).
9	Indicator of parameter, see Table 6.
10	Indicator of type of level (see Note 2).
11-12	Height, pressure etc. of the level (see Note 2).
13	Year of century)
14	Month of year)
15	Day of month) Reference time of data.
16	Hour of day)
17	Minute of hour)
18	Indicator of forecast time unit (set to 1; time unit hours).
19	Time range (number of forecast time units).
20-24	Reserved (set to zeros).
25	Century of reference time of data, for 1900's, code 20.
26	Reserved (set to zero).
27-28	Units decimal scale factor.

Note (1) Octet 8 of the product definition block

grid description block	bit map block	coded value
no	no	0
no	yes	64
yes	no	128
yes	yes	192

Note (2) Octets 10,11 and 12 of the product definition block.

Octet 10		Octet 11	Octet 12
Value	Meaning		
00-99	Special codes 01 surface of earth 06 maximum wind 07 tropopause	0	0
100	Isobaric level	Pressure in hPa (millibars)	
102	Mean sea level	0	0
109	Hybrid level	Level number (level co-ords in GDB)	

Grid Description Block (GDB)

Octet No.

1-3	Length of grid description block.
4	Number of vertical co-ordinates.
5	Location of vertical co-ordinate parameters (coded as missing if none).
6	Type of grid, see Table 7.
7-32	Grid definition.
	For Lat/Lon grid:
	7-8 number of columns.
	9-10 number of rows.
	11-13 Latitude of first grid point.
	14-16 Longitude of first grid point.
	17 Resolution and component flag.
	18-20 Latitude of last grid point.
	21-23 Longitude of last grid point.
	24-25 i direction increment.
	26-27 j direction increment.
	28 Scanning mode indicator.
	29-32 Reserved.
	33-52 Not used at present.

Bitmap block (BMB) - optional

The BMB contains a missing data bitmap for the data field.

Octet No.

1-3	Length in octets of BMB (even number).
4	Number of unused bits at the end of section.
5-6	If 0 a bitmap follows; if 1 a predetermined bitmap is referenced.
7-nnn	The bitmap.

Binary Data Block (BDB)

The BDB contains both the scaling information needed to reconstruct the original data and the packed data. The data is zero filled to an even number of octets.

Octet No.

1-3	Length in octets of BDB (even number).
4	First 4 bits set to zero, last 4 bits give number of unused bits at the end of the block.
5-6	Scale factor (E).
7-10	Reference value (R) (minimum value).
11	Number of bits into which the data is packed.
12-nnn	Binary data.

End Block (EB)

Octet No.

1-4	'7777' indicates end of message (coded CCITT-ITA No.5).

Communications Trailer

The following four octets are added after the end block.

Octet No.

1-4	Carriage return, carriage return, line feed, end of transmission (0D0D0A03) hex.

APPENDIX A **Tables**

TABLE 1 TYPE PARAMETERS (Octet 2 of WMO header)

Type	Accuracy	Parameter	Unit
H	0	Height	m
T	-3	Temperature	degrees C
U	-2	Eastward wind component	m/sec
V	-2	Northward wind component	m/sec
P	0	Pressure	hPa (Mb)
R	0	Relative humidity	%
O	-6	Vertical velocity	Pa/s

TABLE 2 GRID AREA AND LOCATION (Octet 3 of WMO header)
(Octet 7 of PDB)

GRID ARE (WMO)	OCTET 7 PDB	RESOLUTION (LON x LAT)	AREA COVERAG	GRID COLS	SHAPE ROWS	GRID POINT
S	14	2.5 X 2.5	50W-70E,0-90N	37	49	1813
T	15	2.5 X 2.5	70E-190E,0-90N	37	49	1813
U	16	2.5 X 2.5	170W-50W,0-90N	37	49	1813
V	17	2.5 X 2.5	50W-70E,90-0S	37	49	1813
W	18	2.5 X 2.5	70E-190E,90-0S	37	49	1813
X	19	2.5 X 2.5	170W-50W,90-0S	37	49	1813

Notes on contents of Table 2

1) The grid points are laid out in a linear array, such that the longitude index is the most rapidly varying. The first point in the message is at the western most meridian and the southern circle of latitude.

2) Data for the pole points are given as a polar row in each of the bulletins S,T,U,V,W,X, Wind components at the poles are given by the formulae:

$$u = -\text{speed} \times \sin(dd)$$
$$v = -\text{speed} \times \cos(dd)$$

where dd is the direction, as reported according to the specification of wind direction at the poles (refer to WMO Manual on Codes publication No. 306 Vol 1 code Table 878).

At the North Pole the observer faces into the wind and reports the value of the west longitude meridian along which the wind is coming at them; at the South Pole the observer does likewise but reports the east longitude meridian value.

TABLE 3 FORECAST HOUR DESIGNATOR (Octet 4 of WMO header)

When 'H' is first letter of abbreviated heading

Designator	Forecast Hour
A	00 analysis
B	06 hour forecast
C	12 hour forecast
D	18 hour forecast
E	24 hour forecast
F	30 hour forecast
G	36 hour forecast
H	42 hour forecast
I	48 hour forecast
J	60 hour forecast
k	72 hour forecast
L	84 hour forecast
M	96 hour forecast
N	108 hour forecast
O	120 hour forecast
P	132 hour forecast
Q	144 hour forecast

TABLE 4 LEVEL DESIGNATION (Octet 5 and 6 of WMO header)
(Octet 10 of PDB)

Designator	Pressure Level
98	Mean sea level pressure
97	Level of tropopause
96	Level of maximum wind
99	1000 hPa
85	850 hPa
70	700 hPa
50	500 hPa
40	400 hPa
30	300 Hpa
25	250 hPa
20	200 hPa
15	150 hPa
10	100 hPa

TABLE 5 GENERATING MODEL (Octet 6 of PDB)

From Table 2677, WMO Manual on codes, pub No. 306, vol 1 see also WMO-No.9 vol B.

Designator		Model
dec	hex	
15	0F	U.M. Global Analysis
45	2D	U.M. Global Forecast

TABLE 6 PARAMETER NUMBER (Octet 9 of PDB)

From WMO Manual on codes, pub No. 306 vol 1 part B code Table 2 Version 1

Code Figure	Field Parameter	Unit
01	Pressure	hPa (Mb)
02	MSL Pressure	hPa (Mb)
07	Height	m
11	Temperature	degrees C
33	Eastward wind component	m/sec
34	Northward wind component	m/sec
39	Vertical velocity	Pa/s
52	Relative humidity	%

TABLE 7 GRID TYPE (Octet 6 of GDB)

Code Figure	Grid Type
0	Latitude/Longitude grid
1	Mercator projection
2	Gnomonic projection
3	Lambert conformal etc.
4	Gaussian latitude/longitude grid
5	Polar stereographic projection

APPENDIX B

GLOBAL PRODUCTS FROM THE UNIFIED MODEL (Areas S,T,U,V,W,X)

Field	Level	Time																
Wind	1000 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	850 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	700 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	500 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	400 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	300 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	250 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	200 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	150 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Wind	100 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	1000 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	850 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	700 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	500 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	400 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	300 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	250 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	200 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	150 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Temp	100 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	1000 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	850 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	700 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	500 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	400 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	300 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	250 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	200 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	150 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Ht	100 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Rel. Hum.	1000 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Rel. Hum.	950 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Rel. Hum.	850 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Rel. Hum.	700 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Rel. Hum.	500 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Vert. vel.	850 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Vert. vel.	700 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Vert. vel.	500 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Vert. vel.	300 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Vert. vel.	250 (hPa)	00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Trop. pressure		00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Trop. temp		00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Trop. height		00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Max. Wind Lev (hPa)		00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Max. Wind speed		00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144
Max. Wind Height		00	06	12	18	24	30	36	42	48	60	72	84	96	108	120	132	144

APPENDIX C **Example of GRIB messages**

In this example, the encoding is for a 06 hour forecast of 250 hPa temperature on the S grid, from the initial reference time of 00z, November 18 1992.
There will be 16 octets of communications header followed by:

WMO header

Octet No	Hex form	Description
1	48	'H'
2	54	Type parameter ('T' = temperature)
3	53	Grid identification ('S')
4	43	Time difference between reference time and the validity time of data ('B' = 6hrs)
5-6	3235	Level of data ('25' = 250 hPa)
7	20	Blank
8-11	45475252	Originating centre ('EGRR')
12	20	Blank
13-14	3138	Day of month ('18')
15-18	30303030	Hour and minute of reference time ('0000')
19-21	0D0D0A	Two carriage returns and a line feed

Indicator Block(IB)

Octet No	Hex form	Description
1-4	47524942	'GRIB'
5-7	000738	Length of message
8	01	GRIB edition number

Product Definition Block(PDB)

Octet No	Hex form	Description
1-3	00001C	Length of block (28 octets)
4	01	Parameter table version number
5	4A	Identification of centre (4A = Bracknell)
6	2D	Model ident. (2D=Global Forecast Model)
7	FF	Grid ident. (255 = Grid Description Block used)
8	80	Flag (128 = GDB included)
9	0B	Parameter number (11 = Temperature)
10	64	Type of level (100 = isobaric)
11-12	00FA	Pressure of level (250 hPa)
13	5C	Year of century (92)
14	0B	Month of year (November)
15	12	Day of month (18th)
16-17	0000	Reference time of data (0000)
18	01	Forecast time unit (hours)
19	06	Time range (T+06)
20-24	0000000000	Reserved
25	14	Century (20)
26-27	0000	Reserved
28	00	Decimal scale factor

Grid Description Block(GDB)

Octet No	Hex form	Description
1-3	000020	Length of section (32 Octets)
4	00	Number of vertical co-ordinates
5	FF	255 missing
6	00	Latitude/longitude grid
7-8	0031	Number of columns(49)
9-10	0025	Number of rows(37)
11-13	000000	Latitude of first grid point (00)
14-16	04BAF0	Longitude of first grid point (310000)
17	80	Resolution and component flag
18-20	015F90	Latitude of last grid point (90000)
21-23	068FB0	Longitude of last grid point (430000)
24-25	09C4	i direction increment (2500)
26-27	09C4	j direction increment (2500)
28	40	Scanning mode
29-32	00000000	Set to zero

Bitmap Block (BMB)

Not included

Binary Data Block(BDB)

Octet No	Hex form	Description
1-3	0006F0	Length in octets of BDB
4	00	Number of unused bits at end of section
5-6	8003	Scale factor (E = -3)
7-10	42CE5FFF	Reference value (R = 206.357)
11	08	Number of bits into which data is packed
12-nnn	BB	Binary data

End Block (EB)

Octet No	Hex form	Description
1-4	37373737	End of message indicator (7777)

The End Block will be followed by the communications trailer 0D0D0A03 (hex).

Example of a Bitmap Block

Octet No	Hex form	Description
1-3	000232	Length of section
4	04	Number of unused bits at end of section
5-6	0000	If 00 bit bap follows if 01 predefined bitmap
7-nnn	ADB5.....	Bitmap